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INTERNATIONAL GEOPHYSICAL COOPERATION PROGRAM --

SOVIET-BLOC ACTIVITIES

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I. ROCKETS AND ARTIFICIAL EARTH SATELLITES

"Priroda" Lead Article Reports on the Soviet Ballistic Rocket

On the evening of 20 January 1960 there was launched a powerful multistage ballistic rocket from the territory of the Soviet Union; it traveled a tremendous distance and landed accurately in a predetermined part of the Pacific Ocean. This rocket was designed to put heavy earth satellites into orbit and for making cosmic flights to the planets of the solar system. The following represents the views of Prof. B. V. Kukarkin on this subject:

The future tasks of space study present some new problems associated with the fact that the reaching of the nearest planets, Mars and Venus, for example, is a more complex matter than that of reaching the Moon. The shortest distance to these planets is more than 100 times greater than the distance to the Moon. Consequently, an error of 200 km on a flight to the Moon from the Earth would be equivalent to an error of several tens of thousands of kilometers on a flight to the nearest planet. Therefore for a successful launching of cosmic rockets for the purpose of approaching Mars or Venus, it is necessary to have more rigid requirements for the performance of all elements involved in the travel of the rocket. The specifications required for a Moon shot would be far inadequate for a rocket intended to hit more distant bodies (Mars or Venus) at a given moment and at a given point. The experiments with the multistage ballistic rocket made on 20 and 31 January 1960 show that there is every reason to expect that the necessary accuracy can be achieved.

In actuality, the first launching showed that the rocket on falling into the ocean deviated from the computed point by less than 2 km. Such accuracy makes it a sure thing that we will be able to hit Mars or Venus with a rocket at a previously computed distance with a tolerance of several thousand kilometers.

I would like to make note of other possibilities in the field of astronomy that have been opened up by these remarkable experiments. It is obvious that the accomplishment of long-range flights in the future will enable us to deliver to other planets apparatus, instruments and other means for the transmission of information to the Earth. As a result it will be possible to get such data about Venus or Mars as would be impossible to dream of if the investigations were made from the Earth and through the Earth's atmosphere.

In respect to our own satellite, the Moon, we may expect new major discoveries by flights made around that body and by the direct establishment of permanent stations on its surface. It is probable that these stations will be equipped with automatically operating instruments, and in the more distant future, Man will undoubtedly be able to directly explore the planets of the solar system.

The successful launchings of the powerful ballistic rocket are an important step on the way to the direct study of other planets. ("New Attainment of Soviet Science," unsigned article, Priroda, No. 2, 1960, pages 3-4)

"Nedelya" Reports on Lecture Delivered by Dr. I. S. Shklovskiy

The following is a summary of the contents of a recent lecture delivered by Dr. I. S. Shklovskiy entitled: "The Study of Cosmic Space by Rockets and Satellites." It should be emphasized that there is no evidence that the authors of this article are directly quoting the lecturer.

The lifetime of the third Soviet cosmic rocket was expected to end in March 1959, but later observations forced a revision in this estimate. The original revision gave the rocket eight months more -- but this estimate has now been revised again. It is now predicted that the rocket will fall in the month of April of this year. Why was the prediction so faulty? What was responsible for the error? (Translator's note: These questions are asked in the article, but are not specifically answered.)

The article then proceeds to a review of the facts concerning our upper atmosphere that are now generally known, although our concepts of the atmosphere have been so greatly altered in the last few years. The authors discuss the "breathing" of the atmosphere and the theory of corpuscular radiation; this is followed by a discussion of whether or not the Earth has a corona. Thereafter the subject shifts to that of solar "winds," not winds at all, of course, but the movement of corpuscles from the surface of the Sun.

This article, "meaty" as it is, was published in a journal for popular consumption; it wanders from topic to topic, touching only briefly on the subject matter concerned. ("The Earth Satellites Speak," by G. Goryachev and T. Mashkevich, Nedelya, No. 10, 1960, pages 8 and 10)

II. UPPER ATMOSPHERE

"Priroda" Reviews Book "The Nature of the Moon"

The author, well known for his works on the investigation of the Moon, possesses the ability to tell about the most complex astronomical problems in a lively and interesting way. All the material related to the nature of the examined heavenly body is divided into three chapters: The Moon as a Heavenly Body, The Topography of the Moon, The Physics of the Moon's Surface. Each of the problems is treated on the basis of the most recent research by both Soviet and foreign scientists. In the final chapter N. N. Sytinskaya (the author) examines a problem of interest for a wide circle of readers -- the physical conditions that will be encountered by the first people to tread on the Moon's surface. This small book is supplemented by a full list of the names of lunar seas and craters.

This book, 176 pages long, sells for four rubles 25 kopecks. It was published in 1959 in Moscow. (Priroda, No. 2, 1960, page 118)

Aurora Observed in Sinkiang -- Full Translation of a Brief Note in "Priroda"

On 15 June 1959 a group of scientists of the Academy of Sciences of the USSR and the Academy of Sciences of the Chinese People's Republic returned from a field trip through Northern Dzungaria and the Altai portion of Sinkiang. When stopping for the evening on the eastern part of the Dzungarian depression, on the banks of the Urungu River, at the Kelensay (Ertai) survey mark at 46° N and 90° 20' E, we beheld an unusually bright aurora.

The day was clear, completely cloudless and windless. We were on a hill and the sky was open in all directions. At 2130 hours local time (1830 hours, Moscow time), when that part of the sky at the point of the setting Sun was still somewhat illuminated, the sky unexpectedly grew red as if from an immense conflagration. In 2 to 3 minutes the aurora intensified. It colored a considerable part of the sky in a full, dark, deep and extremely rich crimson-claret color or ruby color. Luminous bright rose-colored pillars flared up and died away against this background. All this illumination resembled hundreds of vertically standing spindle-shaped searchlight beams, growing narrow at both the top and bottom. At this time the lower part of the sky, situated in a narrow band above the horizon, was without color. The center of the aurora was situated a little below the pole star, while the edges extended westward beyond the constellation Ursa Major and eastward beyond the constellation Perseus. Three stars of the constellation Auriga were visible through the aurora. The rose-colored rays first arose in the northeast, then shifted to the northwest. This combination of a rich, dark, crimson-claret background and bright rays continued for a period of 20 minutes -- until 2150 hours. Then the bright rays disappeared, the dark red background became homogeneous and gradually became less intense; at 2230 hours a reddish coloring was still clearly visible in the sky.

Unfortunately, we could not determine where this aurora was still observable. However, in the city of Hu-chen, situated farther south, at latitude 44°, the aurora was also clearly visible (information from Lim Pei, soil scientist on this same expedition). It was not observed in the city of Urumchi; this was probably due to the dustiness of the air in this region.

Since the problem of the origin of auroras has again attracted the attention of astrophysicists because of the data collected by Soviet earth satellites, we consider it pertinent to note still another fact. The summer of 1959 in Sinkiang was not distinguished by high temperatures. However, the day following the aurora was unusual in this respect: from 1100 hours to 1540 hours the hot wind blowing from the west was accompanied by extremely frequent and very strong gusts of a burning wind such as we had never observed in the course of three years' work in Sinkiang, including its southernmost parts situated at latitude 36°. ("Aurora in China," by Professor B. A. Fedorovich, Priroda, No. 2, 1960, page 105)

Radioelectronics in the Cosmos -- Full Translation of an Article by V. I. Siforov, Corresponding Member of the Academy of Sciences of the USSR

One of the striking accomplishments of the Soviet automatic interplanetary station is the photographing of the invisible side of the Moon and the radio transmission of these images to the Earth. For the first time in the history of mankind it has proven possible to see that part of the surface of the Earth's natural satellite which had previously never been observable. In the scientific investigation of the Moon and the cosmic space surrounding it an important role has been played by the scientists and designers working in the field of radioelectronics.

For the first time in the entire history of radioelectronics the Soviet automatic interplanetary station accomplished the transmission of half-tone images for immense distances by means of a television system. This has opened up alluring possibilities for photographing the surfaces of other heavenly bodies, of Mars and Venus in particular.

Soviet specialists were faced with the problem of overcoming difficulties of design and construction of radio apparatus for use in space and on the Earth's surface. Included among these difficulties were the following: the limited power of the radio transmitter placed aboard the automatic interplanetary station, the immense distances of space, and the extremely small intensity of the radiowaves arriving at the Earth. When there are very weak signals the internal noises of radio receiving apparatus at the Earth's surface and radio interference of cosmic origin are detrimental factors. It was necessary to guarantee that the weak, useful signals be distinguishable against this background of interference. We can judge how weak the useful signals were by merely stating the fact that their power was 100 million times less than the power of the radio signals reaching the antenna of an ordinary television set. Just a few watts -- that was the power of the radio transmitter carried into space; it was this transmitter that sent to Earth all the scientific information for a distance of 470,000 km from the Earth. Each watt of the power radiated by the radio transmitter, as a result of its passage through an immense sphere with its center at the momentary position of the interplanetary station, produces on each square meter of the Earth's surface a power that is approximately three times less than one billionth of one billionth of a watt.

The great difficulties in receiving such extremely weak radio signals were overcome by using highly sensitive radio receiving apparatus and high-quality antennas and also by using speeds of transmission for the images that were tens of thousands of times slower than the speed of transmission in ordinary television centers at the Earth's surface.

In comparison with the first two cosmic rockets, our third rocket had a number of important innovations. The apparatus aboard was designed for a greater longevity. What were the measures used to accomplish this? First, solar batteries were included among the various different power sources; these made it possible to transform the Sun's energy directly into electrical energy. Second, an operating regime more economical in its consumption of electric power was incorporated for use in the functioning of the various instruments and the transmission of information. The transmission of information was accomplished in accordance with a fixed program, from 2 to 4 hours each day. Third, the control of the apparatus aboard the station was accomplished from the Earth. This made it possible to switch on the instruments aboard the station only when it was necessary to do so. All this provided a considerable economy in the consumption of electrical power from the sources of supply.

Very high accuracy was already achieved at the time of the launching of the second Soviet cosmic rocket. It should be noted that if the initial velocity of the container of this rocket deviated by only a few hundredths of a percent, it would not have reached the Moon's surface. The accuracy of the initial data of motion of the third cosmic rocket would have to be still greater, since it was necessary to predict its travels for a considerably greater period of time and compute the position which it would occupy in space after covering a route on the order of a million kilometers -- from the Earth to the Moon and back to the region of the Earth.

The required accuracy was brilliantly insured by the efforts of Soviet specialists. Already in the initial period of travel of the automatic interplanetary station it has become clear that the established objective will be attained. A comparison of the actual and computed trajectories has shown that they coincide with a high degree of accuracy.

The role of radioelectronics in the study of cosmic space by means of satellites and rockets is exceptionally great. The third artificial satellite has already been revolving around the Earth for a year and a half. The chemical and solar power sources are providing the prolonged and stable operation of the radio transmitter "Mayak" ("Beacon"), radiating radiowaves on a frequency of 20.005 mc.

At the present time, when the power of the chemical batteries has been exhausted, the powering of the transmitter is being accomplished by solar batteries and the transmitter is emitting signals during the period when the satellite is situated outside the Earth's shadow.

Observation of the passage of the radio signals sent by the transmitter has provided supplementary information about the ionosphere and the propagation of radiowaves. It can even be stated that without radioelectronics it would be impossible to set up these remarkable experiments.

What is the principle role of radioelectronics? By means of electronic computers there have been made preliminary computations of a great number of alternatives of different trajectories for the travel of cosmic rockets, the computation of permissible inaccuracies in the values for initial velocities, the directions of travel, the moments of separation of the container, etc. The artificial heavenly bodies -- satellites and rockets -- transmitted by radio abundant scientific data about the most varied properties of cosmic space. Finally, by means of the radio electronic apparatus there has been accomplished a checking of the corrections of the selected flight trajectories of the satellites and rockets in their process of travel in the initial stages of their course. On the third Soviet cosmic rocket the control of on-board apparatus was accomplished from the Earth by radio and many other things have been achieved by means of radioelectronics.

During the last two years our scientists have achieved immense successes in increasing the range of radio transmission. Whereas radio transmission from the artificial earth satellites to the Earth was accomplished over a distance of several hundred kilometers, with the first, second, and third cosmic rockets the range of action of these transmitters became a matter of several hundred thousand kilometers. There was also a considerable increase in the rapidity of transmission of scientific information from aboard the automatic interplanetary station in comparison with that which was achieved on the first and second Soviet cosmic rockets. For the first time in the history of radio engineering and electronics there was achieved the automatic control of on-board apparatus of the third cosmic rocket at a distance of about 500,000 kilometers. It was achieved by means of a radio communication line "Earth-Station." This made it possible to more rationally utilize the power resources of the interplanetary station. The radio transmitter and a number of other elements of the station were switched on only in those periods of time which corresponded to the most favorable conditions for the transmission of information along the line of the cosmic radio connection and when this was necessary from the point of view of determining the characteristics of movement of the station. By means of an automatic system of orientation an end was brought about to the rotation of the entire station around its own center of gravity, arising at the moment of separation

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from the last stage of the rocket, and the station occupied a fixed position in relation to the Moon. This was favorable for the photographing of its reverse side. This complex technical problem was solved by means of an array of apparatus which included solar and lunar pickups to transform the energy of the direct rays of the Sun and those reflected from the Moon's surface into electrical signals. In turn, the received electrical signals reacted on the complex system controlled by the movement of the station around its center of gravity.

In the course of the entire period of photographic work, the automatic system of orientation insured the continual pointing of the station at the Moon. This system was designed in such a way as to practically eliminate static caused by reflected light from the Earth. To accomplish this the station was first oriented on the direct rays of the Sun, and then on the light reflected from the Moon falling on the station approximately from a direction opposite to that of the Sun. In this case the Earth was situated to one side and its light did not disrupt the operation of the system of orientation. On completion of the process of photographing the Moon the orientation system was automatically switched off and the entire station was given a regulated rotation with a fixed velocity, insuring a favorable thermal regime and normal functioning of the scientific apparatus.

More than a few other complex problems have been successfully solved by Soviet radio specialists in this grandiose cosmic experiment. Included among them was a provision for the reliable operation of the radio apparatus under the complex conditions of flight in space, the housing of all the instruments in a limited space, a provision for their electrical supply, the design of a reliable system of control of the instruments from the Earth at distances up to 500,000 kilometers, and a series of others.

In our time science and technology are developing at a rapid pace. Before us are many difficult tasks and problems in the continuing study of cosmic space. However fantastic these problems appear, it is nevertheless possible to assert with great confidence that they will be successfully solved. And this will not be in the very distant future.

However great are the successes of the future mastery of cosmic space, humanity will never forget the Soviet researchers whose self-sacrificing work resulted in scientific feats of immense significance -- the launching of the first artificial earth satellite, the creation of the first artificial planet of the solar system, brilliant investigation of cosmic space near the Moon, the sending of the first automatic interplanetary station into space, the photographing of the unseen reverse side of the Moon and the successful launching of a powerful ballistic rocket which deviated from its target by less than 2 kilometers after having traveled 12,500 kilometers.

There is no doubt that Soviet scientists in the future will also make a worthy contribution to the development of the science of cosmic space. Despite the exceptionally great difficulties involved in interplanetary flights there is every reason to believe that it will be solved successfully. The high level of Soviet science and technology, the rapid tempo of its development and the fundamental superiorities of the socialist structure, are insuring all the necessary conditions for the successful and rapid conduct of scientific research on an immense scale; the great zeal on the part of Soviet scientists to cooperate with the scientists of all countries for the attainment of scientific progress for improving the life of the masses, together with the previously mentioned factors, is very markedly accelerating the solution of the most difficult and urgent problems of the present time. ("Radioelectronics in the Cosmos," by V. I. Siforov, Priroda, No. 2, 1960, pages 5-7)

Determination of Radial Velocities of Stars by Use of a 70-cm Meniscus Telescope and Large Objective Prism

The investigation of radial velocities is an important factor in the study of the dynamics of celestial bodies. In the past a knowledge of radial velocities has played an important role in the discovery and study of such phenomena as the asymmetry of stellar motions, the rotation of the Galaxy and the "red shift" effect in extragalactic nebulas, etc.

At the present time the study of the character of stellar motions in such systems as the stellar associations are assuming great importance. Accordingly, interest is increasing in the radial velocities of these objects.

The determination of radial velocities in the associations should preferably be accomplished by use of an objective prism for the following reasons:

1. The stars forming associations are grouped in relatively small sectors of the sky; for this reason it is possible to simultaneously photograph them with an objective prism and this gives a great economy in time of observation.

2. Making up O-associations are stars of early spectral classes (for the most part); for such stars it is more convenient to use small dispersion during the determination of radial velocities inasmuch as small dispersion enables us to employ briefer exposures, while the accuracy of measurement of the spectrograms depends but little on the dispersion value due to the extraordinarily great width of the spectral lines.

3. By using an objective prism it is possible to photograph weaker stars than is possible with a slit spectrograph with the same aperture of the feeding instrument.

On the other hand, the determination of radial velocities by means of the objective prism is associated with a series of difficulties, among which the most complex is the problem of the reference line and the elimination of a whole series of systematic errors.

The determination of radial velocities requires measurements of the spectral lines relative to those positions which they would occupy in the spectrum of a fixed star. Whereas when using a slit spectrograph the establishment of such reference lines is possible by means of an artificial light source, in a case when an objective prism is used the establishment of such a reference line is impossible. It is also extremely difficult to establish additional lines in the spectrum of the star by use of an appropriate filter.

Also associated with great difficulties is the elimination of numerous systematic errors.

Because of the difficulties mentioned, numerous experiments have been made for the determination of radial velocities of stars by using an objective prism; in a majority of cases they have not attained the desired accuracy. Only in individual cases has it proven possible to reduce errors in measurement to a value less than $\pm 10 \frac{km}{sec}$.

After the installation of the 70-cm meniscus telescope at the Abastumanskaya Astrophysical Observatory, work has been carried on for the purpose of determining the radial velocities of stars by the use of an objective prism.

In photographing stellar spectra we have used the reversion method. The photographing of each region was accomplished twice on the same plate. Between these two exposures we turn the prism 180° on its optic axis. As a result, each star gives an image in the form of two spectra situated side by side. The ultraviolet ends of these spectra are turned in opposite directions; the Doppler shifting of spectral lines also takes place in opposite directions. Therefore in the two spectra received from the one star the relative shifting of the line is twice as great as in either of them individually. There is a corresponding increase in the accuracy of measurements. In this way there is eliminated the need for the establishment of a fixed reference line.

At the same time the reversion to all intents and purposes is free from systematic errors caused by the presence of atmospheric dispersion and the chromatic aberration of magnification.

Other sources of systematic errors are distortion of the prism, distortion of the objective, and change in atmospheric conditions in the interval of time between two exposures; during this time there can also be a change in the position of the plate in the instrument, scale, etc.

The joint action of these factors is the reason why the shifting of the spectral lines becomes a function of the position of the

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star relative to the center of the plate in the instrument. This relationship has the following form:

$$\Delta y = ax + by + cx^2 + dxy + ey^2 + \dots , \quad (1)$$

where Δy designates the shifting (displacement) of the spectral lines caused by the above-indicated reasons, while x and y are the rectangular coordinates of the star.

For computations of the indicated errors we made a detailed investigation of the optical characteristics of the telescope and the objective prism (1). On the basis of these investigations we computed the values of the coefficients of the terms in expression (1), from the second to the fourth power.

In respect to the coefficients of the terms of the first order, their value depends on many factors that are difficult to take into account, and the theoretical computation of these coefficients is accompanied with great difficulties. Therefore the determination of the coefficients a and b, entering into expression (1), is better done empirically.

This is especially convenient in a case when we know ahead of time the values of the radial velocities of many measured stars. In this case it is possible to get the absolute values of the radial velocities of the remaining stars. In a case to the contrary it is necessary to assume that the velocities of the stars measured on one plate are equal, on an average, to zero. On the basis of this assumption we get the relative radial velocities of the stars (the velocity of the individual stars relative to the center of the whole group).

To all intents and purposes the computations are accomplished in the following manner. After the measurement of the plate the initial point of the coordinates is selected in such a way that -- taking terms of higher power into account -- the values of the readings change little from star to star on the whole plate. This means that the values of the coefficients a and b, entering into expression (1), differ little from zero.

The accomplishment of such a step is always possible due to the following reason. As direct computation indicates, the coefficients c and e, standing before the squared terms, considerably exceed in value the coefficients of terms of higher power; therefore the expression (1) to all intents and purposes constitutes a squared form. This fact enables us to zero the coefficients of the terms of the first power by means of a change in the beginning of the coordinate system.

After the introduction of a correction for the terms of higher powers, we compute for each star the differences between the individual and mean values of the readings (for the individual lines). The derived differences, after multiplication by the scale, gives values for radial velocities which require additional correction for terms of the first order.

If the value of radial velocity derived in this manner for the i-th star is designated by v_i, and the real value for radial velocity is designated by v_{io}, then for each star it is possible to write a condition equation:

$$A + Bx_i + Cy_i = \Delta v_i \, , \qquad (2)$$

where x_i and y_i are the rectangular coordinates of the i-th star and Δv_i -- a correction which must be introduced into the value v_i:

$$\Delta v_i = v_{io} - v_i \, . \qquad (3)$$

If sufficient stars with the known radial velocities v_{io} are measured on the plate, then the solution of a system of condition equations (2) gives values for the coefficients A, B, and C, and, consequently, there will be determined the absolute values of the radial velocities.

If there are no objects with known radial velocities among the measured stars, then we assume that:

$$v_{io} = 0 \, . \qquad (*)$$

In this case the coefficient A remains undetermined and we get the relative values of the radial velocities. The condition (4) is equivalent to the assumption that the studied group of stars does not rotate around an axis perpendicular to the line of vision. It is clear that the validity of such an assumption should be checked by one method or another in each individual case.

A case is also possible when the number of reference stars with certain radial velocities is inadequate for the determination of all three coefficients. In this case the coefficients B and C are determined by the above-indicated method, while the reference stars are used for determination of the value A.

At the present time a determination is being made of the radial velocity of stars of types B-F in an association lying near ζ Perseus.

Given below are the results of measurements for a region with the center:

$$\alpha_{1950} = 3^h 54^m, \; \delta_{1950} = +31^\circ 50' \, .$$

Table

BD	m_{pg}	Sp	V	BD	m_{pg}	Sp	V
31°646	10.1	A1	+ 56a	31°674	9.9	A2	+ 25b
31 647	9.7	B9	+ 24a	30 595	9.1	B9	+ 30a

BD	m_{pg}	Sp	V	BD	m_{pg}	Sp	V
31°649	6.5	B4	+ 22c	30°597	10.3	F5	- 65c
32 665	9.6	A8	+ 53a	32 697	8.4	A0	+ 15a
32 666	9.8	A0	- 19b	31 675	10.3	F5	- 22b
31 650	6.6	F9	- 32c	29 654	9.8	A6	- 5b
31 652	8.4	A6	- 9a	29 655	9.8	A1	- 84c
30 576	9.5	F9	- 35c	32 698	10.2	F3	- 15b
31 653	10.3	B9	+ 15b	29 656	9.9	A2	+ 20b
31 655	7.4	B9	+ 29c	31 678	10.3	F0	- 33b
31 658	8.6	B9	+ 19a	30 598	10.3	F0	- 46b
31 657	9.4	B9	- 2b	31 680	9.3	B8	- 16a
29 634	10.3	A3	+ 9b	30 601	10.0	A4	- 19b
30 579	9.8	A0	+ 33b	32 702	10.4	F3	- 6c
31 659	9.6	A3	+ 2a	33 754	10.4	A9	+ 24c
32 669	9.4	A3	0a	30 605	10.6	A3	- 15b
30 581	10.9	A7	+ 1c	33 756	10.0	F5	+ 36c
30 582	6.4	A3	- 58c	32 703	8.5	B9	+ 11b
30 583	10.1	A7	+ 21b	33 758	10.0	A1	- 8b
32 674	9.2	A0	- 111a	31 686	8.9	A4	+ 17a
32 675	10.6	B8	+ 7b	32 706	9.9	F6	+ 48b
32 676	9.8	B9	- 34b	33 760	10.3	A5	+ 15c
33 731	9.0	F2	- 5b	31 687	9.3	B8	+ 49b
32 678	10.6	A3	- 2c	31 688	10.2	A6	- 46b
29 640	10.1	B8	- 35c	31 689	9.7	B9	- 1b

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BD	m_{pg}	Sp	V	BD	m_{pg}	Sp	V
32°679	8.4	A0	+ 0a	31°690	10.1	F3	+ 32b
32 681	10.9	A8	- 53c	30 607	9.6	F0	+ 10a
33 736	10.0	F3	- 43c	29 663	10.3	A1	+ 12b
30 589	10.0	A1	+ 25b	31 692	8.6	A0	+ 7b
32 683	9.1	A4	+ 6a	31 694	9.8	A0	+ 15b
31 667	10.0	A2	- 17c	33 766	10.1	A1	- 30b
31 669	8.9	A0	0a	30 611	10.1	A5	+ 20b
33 741	9.8	A0	- 2c	32 711	9.9	A3	- 34c
31 670	8.5	A0	0a	30 614	9.4	A2	- 26a
33 743	9.8	A4	+ 11b	32 717	9.8	A0	- 12b
32 690	10.7	A8	+ 121c	32 718	10.1	A3	- 21b
32 691	8.6	B8	- 26a	31 705	9.1	B8	+ 23a
32 695	9.0	A3	- 1a				

The table gives: the number BD, the photographic star magnitude, the spectral class and the relative radial velocity of the star. The spectral classification was made by taking into account the data in source (2). The values of the star magnitudes were taken from the catalog (source 3) or estimated visually, based on the density of the spectra on the negative.

The indices a, b, and c designate the quality of determination of velocity; the index a designates stars for which the mean error in determination is $\pm 7 \frac{km}{sec}$, the index b designates measurements with a mean error of $\pm 9 \frac{km}{sec}$, while the index c designates the radial velocities for which the errors constitute $\pm 13 \frac{km}{sec}$.

With the aid of stars BD + 31°649, BD + 31°650 and BD + 30°582, for which the radial velocities are known (4), we determined the correction for the conversion of the relative radial velocities (the data in the table) into absolute values. This correction was equal to $+ 14 \pm 8 \frac{km}{sec}$.

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("Determination of the Radial Velocities of Stars by Use of a 70-cm Meniscus Telescope and Large Objective Prism," by R. I. Kiladze, Soobshcheniya Akademii Nauk Gruzinskoy SSR, Vol. 23, No. 5, 1959, pages 535-539) edited

Study of Interplanetary Ionized Gas, High-Energy Electrons and Corpuscular Radiation of the Sun by the Second Soviet Cosmic Rocket

Experiments with a three-electrode trap for charged particles were made on the 1st, 2d and 3rd Soviet cosmic rockets. The most statistically valuable data from the experiments in question (about 12,000 individual measurements of collector currents) were received during the flight of the second cosmic rocket. Therefore in the article that follows we essentially set forth the data for the second rocket. The volume of information derived about the operation of the three-electrode traps on the 1st cosmic rocket was substantially less; the data from the automatic interplanetary station (3rd cosmic rocket) is presently only partially processed. Nevertheless, considering the importance of the observed recurrence of the results, we will give below individual citations to the data derived during the flights of the 1st and 3rd cosmic rockets.

On the Soviet cosmic rocket launched to the Moon on 12 September 1959 an experiment was set up for the study of interplanetary ionized gas, electrons with the energies W greater than ~200 ev, and the corpuscular radiation of the Sun. With the assistance of a radiotelemetric system at the time of the flight we recorded electrical currents created by the charged particles falling into traps set in a container separate from the rocket with the scientific apparatus. On the surface of the container there were four three-electrode traps, situated at the corners of a tetrahedron inscribed in a sphere. Each trap consisted of a hemispherical outer nickel grid (with a radius of 30 mm), within which there was a flat nickel collector. Between the collector and the outer grid there was a flat wolfram inner grid. The potentials of the electrodes of the traps relative to the body of the container were: the φ_K collectors = - (60 ÷ 90) v, inner grids φ_{g1} = - 200 v; the outer grid had the following potentials φ_{g2} respectively: - 10; - 5; 0 and + 15 v (see Figure 1).

The basic purpose of the inner grids was the suppression of the photoeffect from the collectors, arising under the influence of ultraviolet radiation from the Sun, and also the suppression of secondary electron emission due to the bombardment of the collectors with electrons and protons. The outer grids of the traps were given different potentials in order to make it possible to estimate the energies of the positive particles entering the traps and, in particular, in order to distinguish the currents which can be created by the protons of interplanetary stationary plasma (with energies on the order of 1 ev) from currents created by the protons of corpuscular currents having energies 3 orders greater. The electrons of the stationary plasma (with energies to 1 ev) and of solar corpuscular currents (with energies up to 25 ev) do not play a role in the establishment of collector currents in the traps, since they cannot overcome the retarding field created by the difference in potentials between the inner and outer grids (equal to ~ - 200 v). The electrons moving in the Earth's magnetic trap (in the so-called outer radiation belt), having sufficient energy to overcome the retarding field between the grids of the trap, can create a negative collector current.

It should be borne in mind that the negative collector current is also created by part of the photoelectrons emitted by the inner grid during its illumination by the Sun and which enter the collector under the influence of the electrical field between the grid and the collector. If the trap is not illuminated by the Sun (and the traps were situated on the container in such a way that at least one of them was always in the shadow), the negative current can be created only by high-energy electrons held by the geomagnetic field.

In the selection of the characteristics for the apparatus the following models were taken as the most probable models of interplanetary gases (in accordance with data existing in the literature, sources 1-3). A. There is a stationary gaseous medium consisting essentially of ionized hydrogen with a concentration of n_i = $5 \cdot 10^2 \div 10^3$ cm^{-3}, with an electron temperature on the order of 10^4 °K, close to ion temperature. B. There are only sporadic corpuscular currents, consisting of protons and electrons with velocities of $(1 \div 3) \cdot 10^8$ cm · sec^{-1} and with concentrations of $n_i \approx 1 \div 10$ cm^{-3}. We also had in mind the possibility of a case C -- the simultaneous existence of A and B. It was expected that in case A there would be expected a decrease in the value of the collector currents I_k with an increase of φ_{g2} and an absence of positive currents I_k when φ_{g2} = + 15 v. In the case B the positive values of I_k should be identical independent of the value of φ_{g2}. In the case C positive values of I_k should be observed in all the traps, but decrease with an increase in φ_{g2}.

The amplifiers of the collector currents and the telemetric system make it possible to record positive collector currents from 10^{-10} to $50 \cdot 10^{-10}$ a, and the negative collector currents from 10^{-10} to $15 \cdot 10^{-10}$ a. The instantaneous values of each collector current were recorded twice each minute.

While moving along its trajectory, the container with the scientific apparatus simultaneously made complex rapid rotational movements. Due to this factor the orientation of each trap relative to the velocity vector and direction to the Sun changed continually; this caused corresponding variations in the collector current (see Figure 2). The maximum (like the minimum) values corresponded to certain orientations of the container that were close to one another. Therefore changes in the value of I_k along the trajectory, depending primarily on the surrounding medium, can be described by means of curves enclosing the maximum and minimum values of I_k. In this case the influence of rotation of the container on the results of the experiment can to a certain degree be excluded.

In a similar way, Figure 3 shows the experimental results in that part of the trajectory up to 25,000 kilometers from the Earth's surface and Figure 4 shows the results beginning at a distance of 25,000 kilometers and lasting to the falling of the container on the Moon.

The absence of similarities in the variation of the curves in Figure 3 is evidently due to peculiarities in changes in the orientation of the different traps relative to the velocity vector of the spherical container and is associated with their different positions on the surface of the complexly rotating container.

At 0215 hours Moscow time on 13 September 1959 when the container was situated at a distance of $R \approx 190,000$ kilometers from the Earth, radio communication between it and the territory of the USSR was disrupted because at that time it was over the Western Hemisphere. After the restoration of communications the character of the recorded collector currents had changed and before the end of the experiment was as indicated in the last part of Figure 4.

An examination of the cited experimental data shows:

1. At distances R from the surface of the Earth to 4 earth radii there is plasma with a temperature of no more than 10,000 degrees. This follows from what we can see clearly in Figure 2 -- the substantial influence of relatively small (5v) differences in the potentials of the outer grids of the traps on the values of the collector currents and from the absence (at distances of $R > 3,000$ kilometers) of a current in the trap with the positive potential in the outer grid. The existence of plasma at the indicated distances from the Earth is confirmed by the results obtained by the 1st cosmic rocket in January 1959 and by the 3rd cosmic rocket in October 1959. (In the latter case to 7,000 kilometers, since at that distance the first period of communication with the interplanetary station ceased.)

Problems associated with estimates of the concentration of the plasma which we discovered here and also the possible concentration of interplanetary plasma (with large values of R), go beyond the limits of this present paper and will be examined separately.

2. In the sector $55,000 < R < 75,000$ kilometers we recorded a current of electrons N on the order of 10^8 cm^{-2} sec^{-1} with energies exceeding ~200 ev. This follows from the fact that during the time of the passage of the container through this sector (more than 1.5 hours) all the traps recorded negative currents only, which, as indicated above, is only possible under the influence of high-energy electrons. The existence of such a current of electrons in the region of this sector of the trajectory of the rocket is confirmed by the results of an experiment on the 1st cosmic rocket in January 1959.

3. Beginning at 0930 hours (Moscow time) on 13 September 1959, before the falling of the container of the 2d cosmic rocket on the Moon, we recorded the passage of the container into a current of positive ions (in all probability protons) with energies exceeding 15 ev; $N \sim 2 \cdot 10^8$ cm^{-2} $\cdot$ sec^{-1}. This follows from the fact that at the indicated time approximately identical collector currents were recorded in all four traps (see last sector in Figure 4).

The existence at different times of currents of protons with energies exceeding 25 ev was discovered with the assistance of similar apparatus at various distances from the Earth (in particular, when $R \sim 125,000$ kilometers) at the time of a number of periods of transmission of radiotelemetric data during the flight of the automatic interplanetary station in October 1959. The recorded currents of protons evidently belong to the solar corpuscular radiation that was thereby observed for the first time in interplanetary space outside the Earth's magnetic field.

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FIGURE APPENDIX

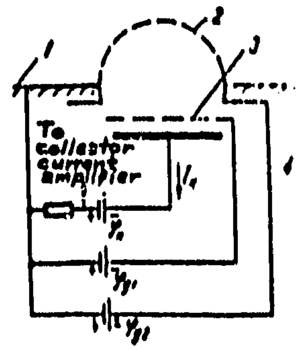

Figure 1. Diagram of the three-electrode trap.
(1) body of container;
(2) outer screen
(3) interior screen
(4) collector

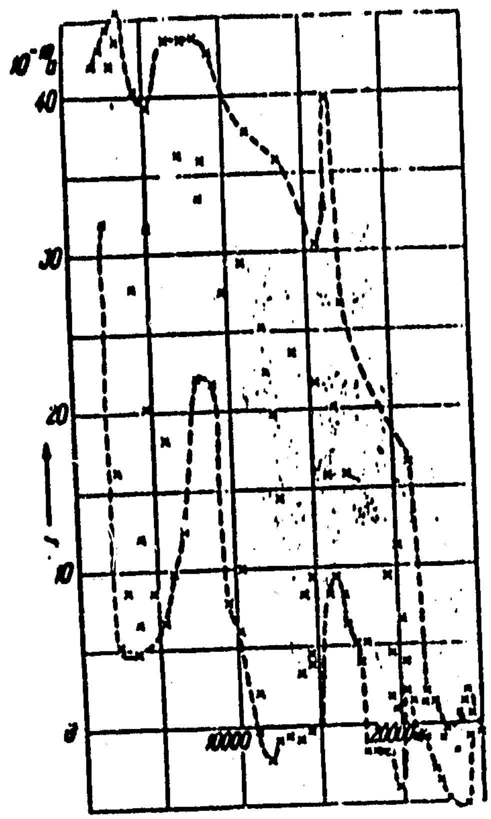

Figure 2. Values of collector currents recorded in the trap with φ_{g2} = -10V in the section R < 25,000 Km

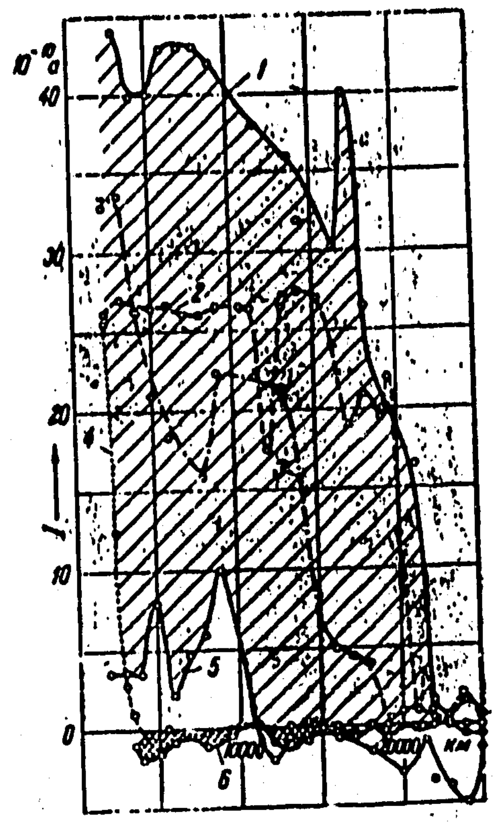

Figure 3. Limits of the collector currents in the section R < 25,000 Km. Upper limits: (1) with φ_{g2} = -10 V, (2) with φ_{g2} = -5V, (3) with φ_{g2} = 0V, (4) with φ_{g2} = +15V; Lower limits: (5) total for traps with φ_{g2} = -10V; -5V and 0V, (6) with φ_{g2} = +15V

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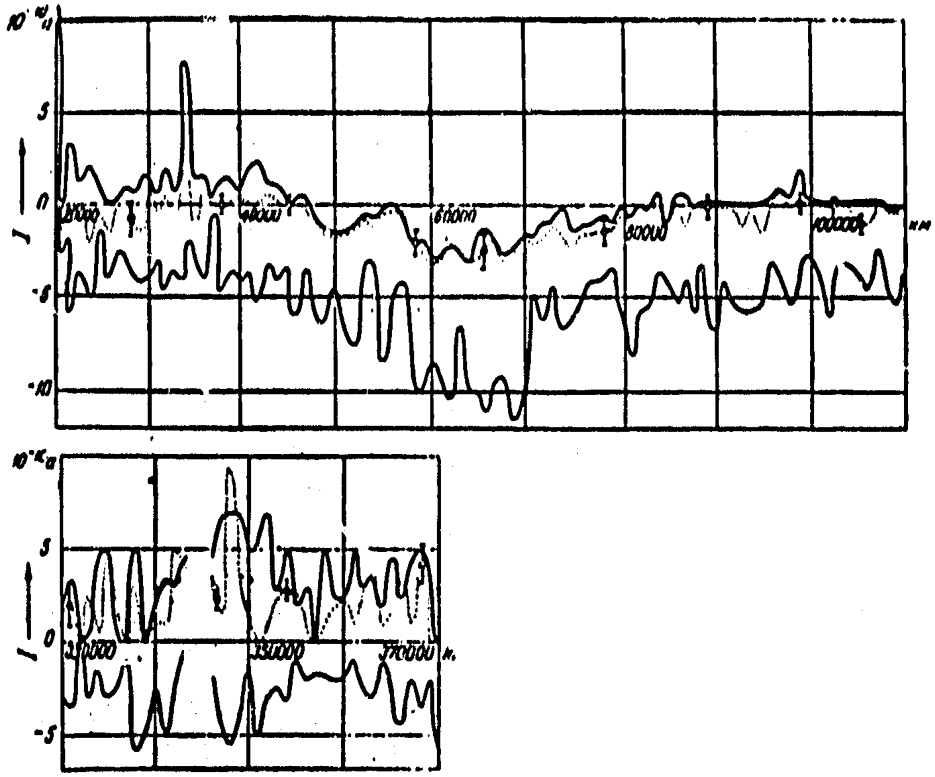

Figure 4. Continuous curve -- the upper and lower limits, corresponding, of the current collectors in the traps with φ_{g2} = -10 V; -5V and 0V. Dotted curve -- upper limit of currents in the trap with φ_{g2} = +15V. The curves are related to sections of the trajectory. The end of the first section (from 100,000 to 190,000 Km) is omitted since it, according to the character of the currents, corresponds to the section from 80,000 to 110,000 Km; the beginning of the second section (from 245,000 to 330,000 Km) is omitted since it, according to the character of the currents, corresponds to the section from 330,000 to 370,000 Km.

("Study of Interplanetary Ionized Gas, High-Energy Electrons and the Corpuscular Radiation of the Sun by Use of Three-Electrode Traps for Charged Particles Carried Aboard the Second Soviet Cosmic Rocket," by K. I. Gringauz, B. V. Bezrukikh, V. D. Ozerov and R. Ye. Rybchinskiy, Doklady Akademii Nauk SSSR, Vol. 131, No. 6, 1960, pages 1301-1304) ditto-ed

Radioastronomical Observations of the Second Soviet Cosmic Rocket

1. The radio interferometer method (1-4) is used extensively in radio astronomy. It is used for the determination of the coordinates of discrete sources of radio noise, for the investigation of inhomogeneities in the ionosphere, for determination of the coordinates of artificial earth satellites, etc. We used this method for observations of the radio signals of the second Soviet cosmic rocket which reached the Moon on 14 September 1959. The angular coordinates of the container were measured with scientific apparatus; we also determined the intensity of the received signal and the character of change of intensity with time.

2. Observations were made on the frequency of the radiation of the transmitter installed in the container, 183.6 mc. A radio interferometer was used that is similar to that already described in the literature (5) but with the introduction of several unimportant changes associated with the need for narrowing the reception band. It is to be understood that if the reception of a signal of a noisy character the sensitivity of the apparatus is increased proportional to the root of the width of the reception band, then in the reception of a monochromatic signal the sensitivity is inversely proportional to the square root of the band width. We used a receiver pass band of 10 kilocycles. The first and second heterodynes were quartz-stabilized. Each of the two antennas, constituting truncated parabolic mirrors with areas of about 200 m^2 each, had amplifier heads with a noise factor of about 5. Reception was accomplished by the method of phase modulation. For separating out the changes in the amplitudes of the signal caused by a change in direction to the source and a change in intensity of the source itself, we used a double radio interferometer as described in source (6). The distance between the two antennas was 175.9 m, which corresponded to an angular width of one lobe of 32' (with normal incidence of the wave). The antennas were situated approximately in an east-west direction and received the signal with horizontal polarization. The tracking of the antennas behind the container and the determination of the number of the lobe of the interference diagram (order of interference) were accomplished in accordance with directives received from the coordination-computing center.

3. With the assistance of the radio interferometer there was a direct measurement of the angle β between the direction to the source of the signal and the perpendicular drawn to the base of the radio interferometer. The value β is determined through the number of lobes n and the parameters of the interferometer by the ratio

$$\sin\beta = \frac{\lambda}{D}(n - \eta) , \qquad (1)$$

where λ -- the length of the wave of the signal received; D -- the base of the interferometer; η -- the parameter determined by the difference of the electrical lengths from each of the antennas to the place of collection of signals. With equal electrical lengths $\eta = 0$.

The azimuth of the source A is connected with the angle β by the ratio:

$$\sin \beta = \sin \gamma \cos z + \cos \gamma \sin z \sin (A - \theta) , \qquad (2)$$

where z -- the zenith angle of the source; $\gamma = 2^\circ 44'$ -- the angle between the horizontal plane and the projection of the base on a vertical plane passing through an east-west line; $\theta = -14'$ -- the angle between the east-west line and the projection of the base on a horizontal plane.

Then

$$A = \theta + \text{arc} \sin \left[\frac{1}{\cos \gamma \sin z} \frac{\lambda}{D} (n - \eta) - \text{tg}\, \gamma \,\text{ctg}\, z \right] . \qquad (3)$$

Of the five parameters (γ, θ, D, λ, and η) entering into the ratio (3), one parameter, γ, is determined by the frequency of emission with corrections for the Doppler effect. Three others, λ, θ, and D, being constants, were determined by a geodetic survey of the mutual positioning of the antennas and were made precise by adjustment. The parameter η, depending on the electrical lengths of the cables and the phase responses of the input stages, can change in time, and therefore was determined before each observation.

The adjustment of the radio interferometer was accomplished by the intensive sources of radio emission Cygnus-A, Taurus-A and Virgo-A. For these sources we used the equatorial coordinates (epoch 1959.5) and the currents of radio emission p shown in Table 1.

Table 1

Source	$P_{183.6}$ WT • M^{-2} • c^{-1}	$\alpha_{1959.5}$	$\delta_{1959.5}$
Cygnus-A	$70 \cdot 10^{-24}$	$19^h58^m05^s$	$+40^\circ 36'.5$
Taurus-A	$18 \cdot 10^{-24}$	$5^h32^m09^s$	$+21^\circ 59'$
Virgo-A	$9 \cdot 10^{-24}$	$12^h28^m47^s$	$+12^\circ 34'$

4. A reliable reception of a signal on approach to the Moon, up to the moment of contact, enables us to reliably determine the time of hitting the Moon's surface and the area of landing of the container with the scientific apparatus. A copy of the interference recording

of the signal on one of the receiving channels in the terminal part of the trajectory is shown in Figure 1. At the moment of cessation of the signal the sinusoidal character of the recording (due to the interference) was replaced by an exponential fall, caused by the cessation of the signal and the presence of constant time. This transition is clearly seen (Figure 1, point A) and fixes the time of signal cessation at 0002 hours 22 sec ± 1 sec (14 September 1959).

Taking into account the time required for the propagation of the signal from the Moon to the Earth, 1.2 seconds, this corresponds to the time of hitting of the container against the Moon's surface of 0002 hours 21 sec ± 1 sec.

The time of cessation of the signal (0002 hours 22 seconds) corresponds to the lobe number $n = 53.43$. For this value the curve A (a, n), computed on the basis of formula (3), intersects the visible disk of the Moon.

When recomputed in selenographic coordinates, taking errors in measurement into account (equal to ± 1' when averaging several readings), this line is transformed into the region shown by heavy shading in Figure 2.

Taking into account the data derived by the automatic array of instruments (8) it should be assumed that the region in which the container with the instruments made its landing on the Moon is the region shown in Figure 2 by heavy shading. The selenographic coordinates of the center of this region are the following: + 30° latitude, - 3° longitude (Archimedes Crater).

5. The intensity of the received signal was determined by comparison with the known radiation of the cosmic source Cygnus-A. The time dependence of the change in signal, reduced to the isotropic radiator situated at the distance of the container, is shown in Figure 3.

Several characteristic periods of change in intensity of the signal were observed: a small one of about 45 seconds and a large one of 45 minutes on 12 September 1959 and 10-13 minutes on 13 September 1959.

The presence of deep fading of the signal may be due to the periodic change in orientation of the container and the Faraday effect in the ionosphere.

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FIGURE APPENDIX

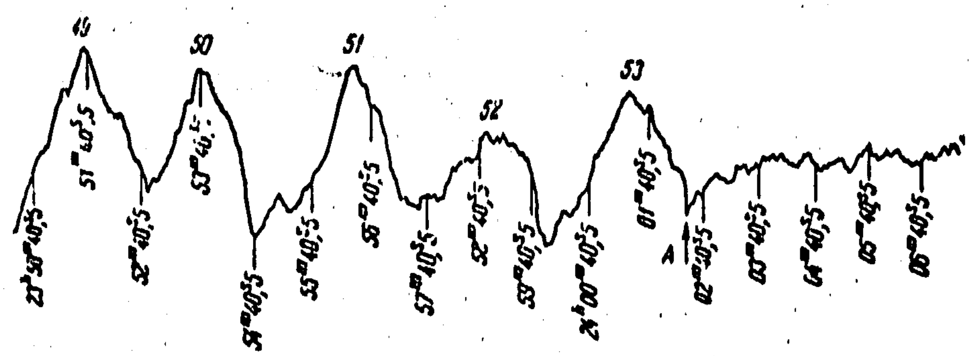

Fig.1. Interference recording of signal during the container's approach to the Moon.
A -- Moment of cessation of signals

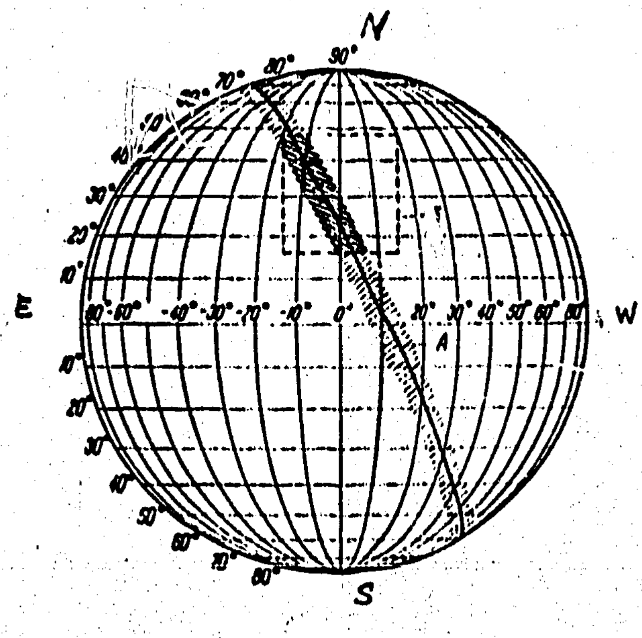

Fig.2. Moon landing of container. Hatched lines -- Radiointerferometer data. B -- data from the automatic measuring complex (8); cross-hatched lines -- region of landing of container. Selenographic coordinates

The Structure of the Electrostatic Field in the Free Atmosphere

Up to the present time no one has solved the problem of the nature of the electrical field of the atmosphere, although there are a series of hypotheses explaining its existence. The most frequently used is the model of a "spherical capacitor" (1, 2). An indirect confirmation of this model is the close correlation between the diurnal march of intensity of thunderstorm activity over the entire Earth and the diurnal march of the intensity of the electrostatic field over the oceans and in the polar regions where it is disrupted to only a small degree by local space charges ("unitary variation").

The theory of the "spherical capacitor" assumes: 1) a monotonous dropoff in the electrostatic field with height and, accordingly, a monotonous increase in potential with height; the potential of the ionosphere, calculated on the assumed change in conductivity with height, is assumed to be equal to ~400 kv; 2) the correspondence of the phase and amplitude of the diurnal variations in the value of the potential of the ionosphere to the phase and amplitude of the "unitary variation" observed on the Earth; 3) the similarity in phase of the changes and the identical nature of the potential of the high layers at the same level at all observation points.

The rationality of the hypothesis explaining the origin of the atmospheric electrical field can be evaluated by investigations of its variation with height.

At the time of the International Geophysical Year and International Geophysical Cooperation Program in the USSR regular soundings of the electrical field of the atmosphere were made by means of LI-2 aircraft at Leningrad, Kiev, and Tashkent (for the instruments and method of measurements see (8)).

In the course of these soundings the change in intensity of the electrostatic field E with height H was measured. The potential of the corresponding point was computed by means of integration of the experimental curve E = f(H). It must be taken into account that a basic part of the resistance of the atmosphere is concentrated in its lower layers (4). Thus, in the 0-6 km layer there is concentrated about 66% of the total resistance of the atmosphere; it may therefore be assumed that the potential at a height of 6 km should not essentially differ from the potential of the ionosphere -- by no more than 30-35%. Therefore changes in potential at a height of 6 km should be essentially similar to changes in the potential of the ionosphere. Disruptions of this similarity can occur because of deviations of atmospheric conductivity from their "normal" values. Since these deviations for the most part occur in the 0-3 ÷ 4 km layer and usually lead to a decrease in conductivity, the computed values of the potential of the ionosphere may prove to be somewhat higher (4).

The processing of data for these measurements gave the following results:

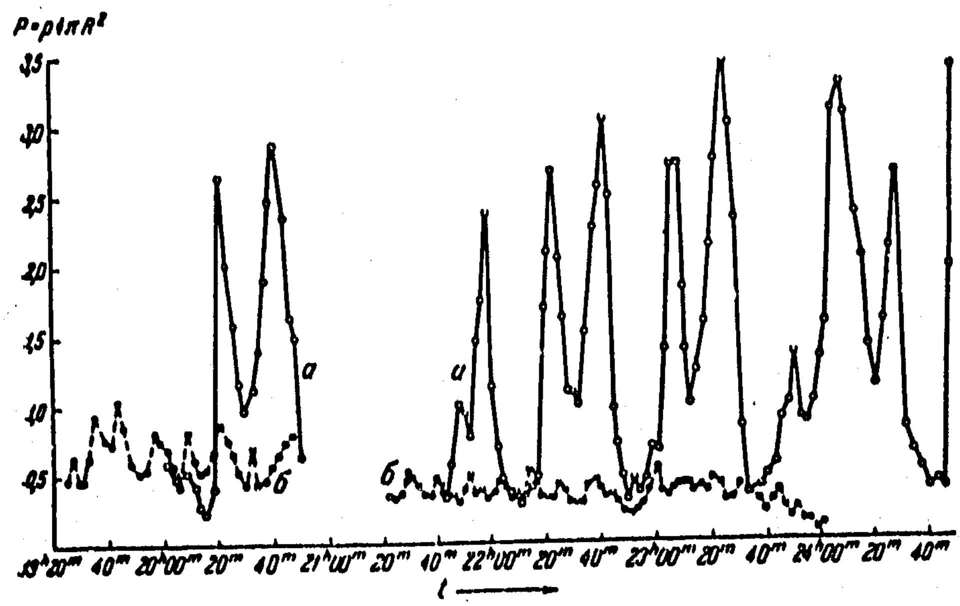

Fig 3. Time-base changes of the signal excluding the effect of distance.
a -- 12 September to 13 September 1959; b -- 13 to 14 September 1959

("Radioastronomical Observations of the Second Soviet Cosmic Rocket," by V. V. Vitkevich, A. D. Kuz'min, R. L. Sorochenko, and V. A. Udal'tsov, Doklady Akademii Nauk SSSR, Vol. 132, No. 1, 1960, pages 85-88)

1) The monotonous pattern of change of field intensity with height is often disrupted, even on clear days. Together with an exponential decrease with height $\underline{H}$ of the field $E = E_0 e^{-aH}$ ($\underline{a}$ changes from 10^{-3} to $1.5 \cdot 10^{-3}$, if $\underline{H}$ is measured in meters), a number of cases are encountered when at some height (most commonly 3,000-4,000 m) the intensity of the field drops to zero or becomes steadily negative. Cases are observed when there is almost no change in the electrical field with height -- it maintains values of 0.25 to 0.35 v/cm to great heights. There is a pattern of variation in the field in which the intensity has a maximum at a height of several hundred meters to several kilometers, usually situated under the boundary of a temperature inversion (9). Above the intensity maximum the sign changes and it becomes negative.

2) The monotonous increase in potential with height is often disrupted even in clear weather.

3) The most probable value of the potential at a height of 6,000 m was less than expected. As can be seen from Table 1, it lies within the limits of 120 to 160 kv; the most probable value of the potential in the ionosphere is therefore about 200-250 kv.

4) The diurnal changes in potential at a height of 6,000 m most commonly are not similar to "unitary variation" but are different for all three points of observation at one and the same time (Figure 2A). Relative variations in the potential in the course of a day at heights of 500 to 6,000 m have a tendency to decrease with height. Minimum variations in the potential are often observed at a height of 3,000 to 4,000 m. Higher aloft the relative variations of the potential often increase again. A shifting of the maximum with height (Figure 2B) is often observed in the diurnal pattern of the potential at different heights. The "unitary variation" of field intensity appears rather clearly (Figure 4) at heights of 200 to 300 m (at Leningrad and Kiev). It begins to fade out above and below, and the maximum of the curve begins to shift.

Our experiments therefore did not confirm the model of a "spherical capacitor."

We can interpret the derived results if we change from the model of a "spherical capacitor" to the model of a charged sphere surrounded by a space charge. Since there is a "unitary wave" (5-7) at the Earth's surface in the polar, mountain and oceanic regions, and since there is a good correlation between the "unitary wave field" and the diurnal pattern of thunderstorms activity over the entire globe (3), it may be assumed that the currents flowing on the Earth in regions with a thunderstorm impart a charge to the Earth and the diurnal pattern of field intensity near the Earth's surface is, in essence, the pattern of density of the Earth's surface charge in areas where it is not disrupted by local space charges.

The Earth is surrounded by a space charge whose field is superimposed on the field of its surface charge and its variations "smear" the variations of the "unitary variation"; therefore the variations of the potential at various heights is caused by the distribution and value of the space charge in the atmosphere. The space charge in the 3 to 4 km layer is often already such that its field capacity completely compensates the field of the Earth's surface charge.

If we subtract the intensity created by the Earth's own charge (E unitary) from the measured intensity of the field, then in the first approximation we can delimit the field caused by the space charge of the atmosphere. Figure 3 shows an example of such an analysis. As we can see, the variations of the measured potential even under undisturbed conditions essentially duplicates the variations of the potential caused by the space charge of the atmosphere. The entire globe can be divided into three regions:

I -- a region of generation of the space charge. We must include here all the regions covered by clouds; the profile of the electrical field in these cases is usually sharply disturbed.

II -- regions where the monotony of the change in intensity of the electrical field with height is disturbed by the space charges introduced from Region I. Included in these cases are profiles diverging from the exponent. This type of profile depends on the value and distribution of the charge in the atmospheric column.

III -- regions where the space charge of the entire atmospheric column is small and does not exercise a substantial influence on the field of the Earth's surface charge. There should be a "unitary variation" in these regions, both at the Earth's surface and aloft.

The fact that "unitary variation" is observed in "disturbed" regions (type region II) only at certain heights (~200-300 m) (Figure 4) is due to the fact that the field of space charges situated above and below this level (for Leningrad) compensate one another, permitting the field of the Earth's own charge to appear in pure form.

Experiments in the sounding of the electrical field of the atmosphere have therefore not confirmed the theory of a "spherical capacitor." Judging by the results of these measurements, it is obvious that it is better to change over from the model of a "spherical capacitor" to the model of a charged sphere, surrounded by a space charge. In order to more seriously support this model, we have need for continuing study of the behavior of the space charge in the atmosphere, the conditions under which it is generated and diffused, and its distribution in the atmosphere.

Table 1

RECURRENCE OF VALUES OF POTENTIAL AT A HEIGHT OF 6,000 METERS IN 1958 (NUMBER OF CASES). VALUE FOR THE POTENTIAL ANTICIPATED ON THE BASIS OF THE GISH SCHEME AT HEIGHTS OF 6,000 M. + 280 KV, IONOSPHERIC POTENTIAL + 400 KV

Range of change of potential in kv

	≤-200	-200÷-160	-160÷-120	-120÷-80
Leningrad	2	2	3	4
Kiev	4	5	4	4
Tashkent (March & September)	1	1	1	1

	-80÷-40	-40÷0	0÷40	40÷80	80÷120
Leningrad	2	5	8	26	38
Kiev	6	5	7	12	21
Tashkent (March & September)	1	1	4	10	17

	120÷160	160÷200	200÷240	240÷280
Leningrad	40	36	23	22
Kiev	25	23	15	12
Tashkent (March & September)	15	7	3	3

	280÷320	320÷360	360÷400	400÷440
Leningrad	10	8	5	2
Kiev	6	5	4	2
Tashkent (March & September)	2	4	3	2

	440÷480	480÷520	>520
Leningrad	2	2	2
Kiev	2	1	1
Tashkent (March & September)	1	1	1

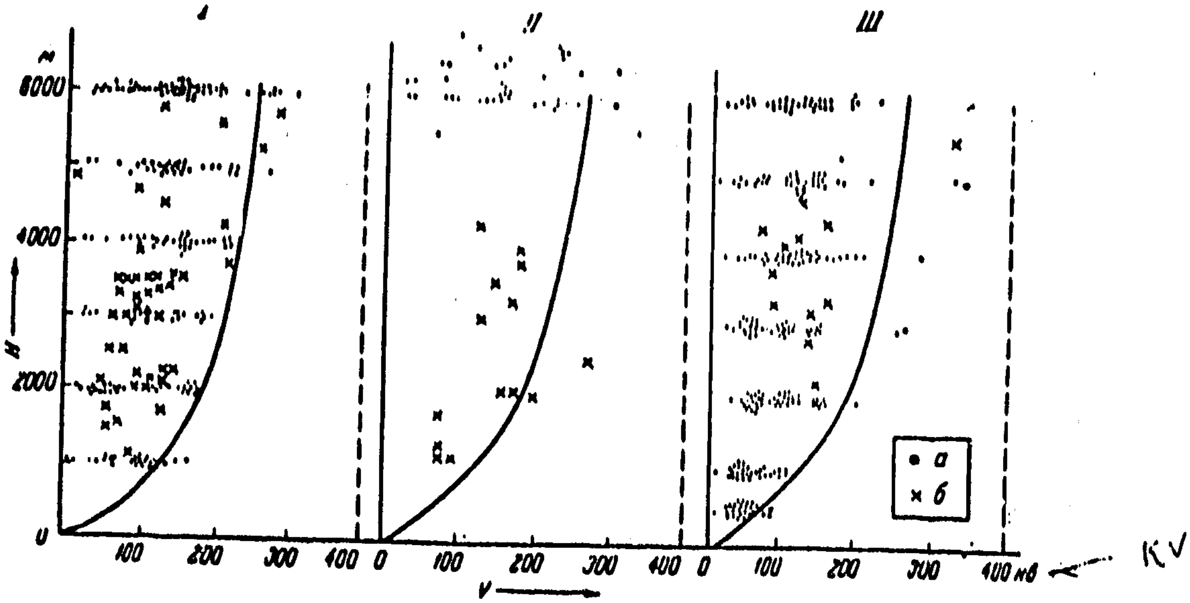

Fig 1. Variation of the electrical potential with altitude: I -- Leningrad, 1958 (75 ascents); II--Kiev, 1958 (50 ascents); III--Tashkent, 1958 (50 ascents); Continuous curve -- variation according to Gish (see [2] for example); a -- measured values of the potential; b -- altitudes where the curve of changes of potential with altitude is maximum, i.e. above the potential decreases

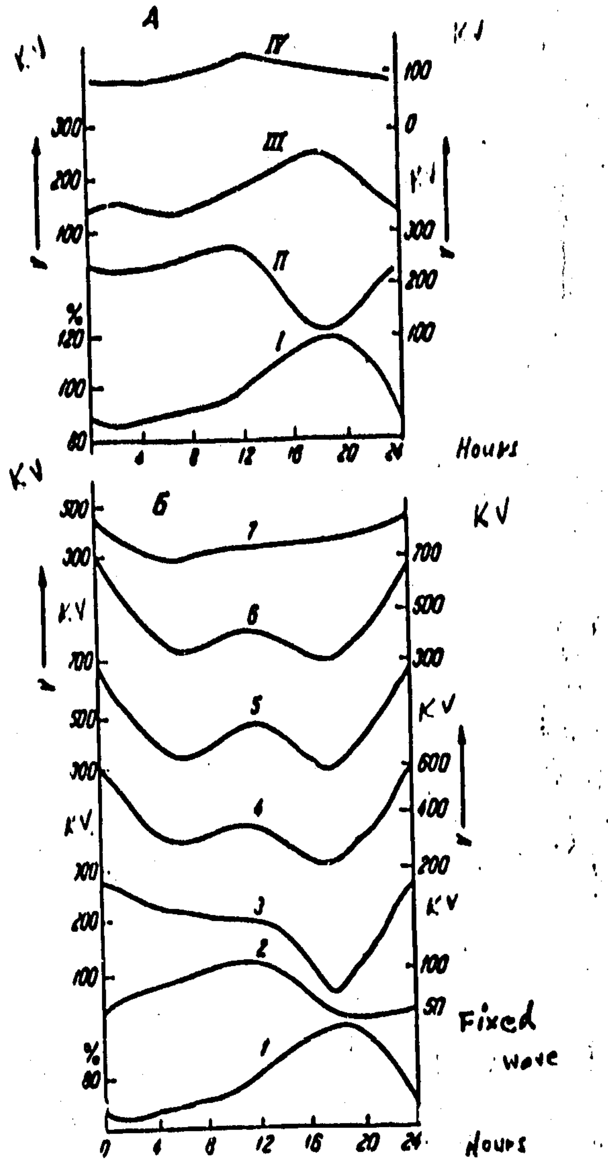

Fig 2. A -- fixed variation (I) and daily changes of potential (II, III, IV) at an altitude of 6,000 M in September 1958 on a clear day: II -- according to Leningrad; III -- according to Kiev; IV -- according to Tashkent. B -- fixed wave (1) and diurnal variation of potential at altitudes from 500 to 6,000 M in Tashkent on clear days in June 1958 (2-7): 2 -- 500 M; 3 -- 1,000 M; 4 -- 2,000 M; 5 -- 3,000 M; 6 -- 4,000 M; 7 -- 6,000 M.

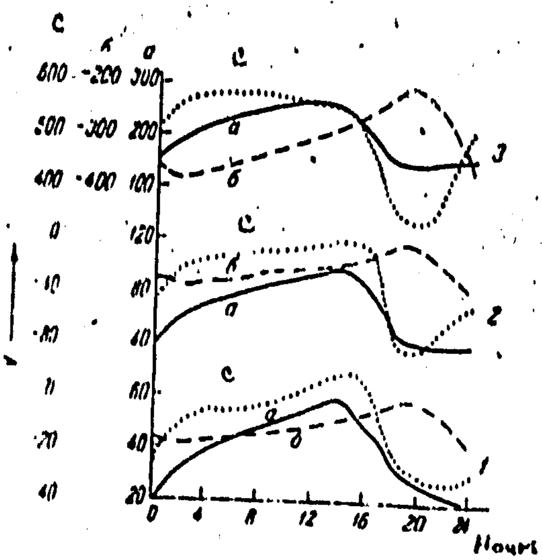

Fig 3

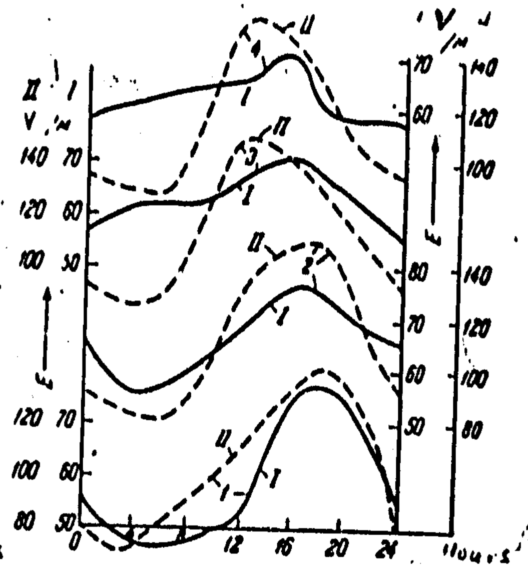

Fig 4

Fig 3. Diurnal variation of the potential at altitudes of 500 M (1), 1,000 M (2) and 5,000 M (3) on clear days in June 1958 in Leningrad. a -- measured potential; b -- potential dependent on the natural charge of the Earth; c -- potential dependent on the total charge of the atmosphere

Fig 4. Diurnal variation of the field at altitudes from 200 to 500 M on clear days in 1958. I -- Leningrad, II -- Kiev. 1 -- 200 M; 2 -- 300 M; 3 -- 400 M; 4 -- 500 M

("The Structure of the Electrostatic Field in the Free Atmosphere According to Data of Investigations During the International Geophysical Year," by I. M. Imyanitov and Ye. V. Chubarina, Doklady Akademi Nauk SSSR, Vol. 132, No. 1, 1960, pages 104-107)

Auroral Studies on Kol'skiy Peninsula

An expeditionary detachment of the Institute of the Physics of the Atmosphere, Academy of Sciences USSR, is conducting scientific investigations in the tundra of the Kol'skiy Peninsula near station Loparskaya.

The members of the expedition recently set up a unique new instrument for studying auroras, a spectrometer. Such an instrument is still unique in the Soviet Union.

The first results of the observations of auroras show that this spectrometer will permit deeper studies of the processes which take place in the upper atmosphere. It makes a precise record of both the visible and invisible portions of a spectrum of an rurora. ("Instrument Studies the Northern Lights," Moscow, Komsomolskaya Pravda, 7 January 1960, page 4)

III. METEOROLOGY

Report on Snow Cover in the Central Urals

The following is the substance of a brief article appearing in a recent issue of the Soviet popular science magazine Prircda:

The Central Urals is that part of the range bounded on the north by 59° 15' and on the south by 55° 54'. It is the lowest and most gently sloping part of the Urals.

There are great differences in the distribution of the snow cover. Peaks are swept clear of snow, as are the windward slopes; this now accumulates many meters deep in the depressions between the mountains. The depth of the snow cover on the interfluves is usually greater than in the valleys between them; this is associated with the wind regime.

The first snowfalls are observed in the second half of September; they form a thin snow cover that rarely lasts more than a day. A permanent snow cover forms at the end of October in the north and at the beginning of November in the south.

In the beginning of winter the depth of the snow cover increases rapidly, slowing down sharply in February. The maximum depth in most regions is attained in the first part of March; thereafter compaction begins, and then thawing.

The density of the snow cover gradually increases. The density of the snow approximately doubles during the course of winter. The depths of the snow cover in the Central Urals varies from 0.5 m to 1 m, decreasing from northwest to southeast (see map showing the period of maximum depth of snow cover). Some years it attains two meters or more. On the eastern slopes of the Urals the snow is approximately twice as deep as on the eastern slopes.

The depth of the snow cover at the same point varies sharply from year to year, in at least one place from 27 to 181 cm.

The thawing of the snow begins in the first part of April and lasts to the beginning of May. The snow remains longest in the mountains, where it sometimes remains year-round in shaded places. ("Snow Cover in the Central Urals," by A. G. Chikishev (Institute of Geography of the Academy of Sciences of the USSR), Priroda, No. 2, 1960, pages 121-122)

Report on an Occurrence of Black Snow

On 11 February 1959 black snow fell on the southern slopes of the Great Caucasus Range in the Ismaillinskiy region over an area of about 30 square kilometers. As reported by I. Yusifov in a note published in the "Azerbaydzhan Pioneer" on 27 February 1959, this began as a typical snowfall for this area and the snow cover was soon 30 cm deep. However, at about 1500 hours, to the amazement of the population of several villages, snowflakes of a black color began to fall and this continued for a period of three or four hours. On top of an ordinary snow cover there has been formed a layer of black-brown snow about 5 to 6 cm thick. The black snow consisted of dust, soot, sand, etc. As a result of the ensuring warming of the snow cover the snow thawed in places. A thin layer of silt-like material remained on the surface of the grass after the snow had melted.

An analysis of synoptic maps shows that on the night of 11 February a small cyclone had developed over the region of the Little Caucasus; moving to the north, during the daytime hours of 11 February it occupied regions of the southern margins of the Great Caucasus. On the southern and southeastern margins of the cyclone, to elevations of 1.5-2 km, there were easterly and southeasterly winds with velocities up to 30-40 km/hr. Above the 2-km layer the wind sharply shifted in direction, becoming westerly. On 10 February there had occurred an intrusion of cold air masses into the area of Azerbaydzhan, accompanied by a snowfall. This in its turn caused a sharp increase in air humidity to the 4-5 km level. Easterly and southeasterly air currents set in due to the thermal minimum over the regions of the southern slope of the Great Caucasus. With them they brought sand, soot, ashes and all kinds of other industrial wastes, contaminating the atmosphere, coming from the industrial regions of the Apsheron Peninsula (Baku, Kishly, Sumgait). These relatively warm air currents, coming into contact with colder and highly humid surroundings, condensed rapidly and the dark particles carried in the air mass served as condensation nuclei. They colored the falling snow a black-brown color. ("Black Snow," by K. M. Melikov /Baku Weather Bureau/ and A. D. Eyyubov /Candidate in Geographical Sciences, Institute of Geography of the Academy of Sciences of the Azerbaydzhan SSSR, Baku/, Priroda, No. 2, 1960, pages 122-123)

IV. GLACIOLOGY

A Report on the Glaciers of the Northern Urals

The following is a summary of a 2-page article by A. O. Kemmerikh, Candidate in Geographical Sciences of the Institute of Geography of the Academy of Sciences of the USSR:

Until 30 years ago it was believed that there were no glaciers in the Urals, but since then over 20 small glaciers with a total area of about 5 square kilometers have been discovered and described.

The largest glacier (1.4 km^2) of the Urals is that named in honor of the Institute of Geography of the Academy of Sciences of the USSR. The second largest (1.15 km^2) and the longest (2.2 km) glacier in the Urals is named in honor of Moscow State University. The third largest of these glaciers (1.12 km^2) is named after L. D. Dolgushin.

All the glaciers of the Polar Urals are concentrated at elevations of 500 to 1,000 m above sea level. At the present time the glaciers are in a stage of retreat; this is evidenced by the high position of the lateral moraines and the deposition of terminal moraines in the valleys below the ends of the glaciers.

The thawing of the glaciers of the Polar Urals in July and August, despite the northerly location, occurs considerably more intensively, for example, than the glaciers of the Tien-Shan and the glaciers of the Pamirs. This is basically due to the low elevation of the glaciers of the Polar Urals above sea level and the considerably greater duration of sunshine at that season above the Arctic circle. The glaciers even thaw intensively during the night hours. ("New Region of Glaciation," by A. O. Kemmerikh, Priroda, No. 2, 1960, pages 78-79)

V. OCEANOGRAPHY

Further Report on Soviet Exploration of the Floor of the Pacific Ocean

The following is a brief summary of a recent Priroda article entitled "Interesting Finds on the Floor of the Pacific Ocean."

The 1957-1958 voyages of the Vityaz' were made in the western half of the Pacific Ocean, from Japan on the north to New Zealand on the south.

Particular attention was paid to the collection of the skeletal remains of animals from the sediments on the ocean floor, such as sharks' teeth and the jawbones of mollusks. In the latter case, the number of items per bottom sample was recorded and the article is accompanied by a map of the quantitative distribution of this bottom material. The text provides some data concerning the size, state of preservation, areal occurrence, and occurrence by depth for both the jawbones of mollusks and sharks' teeth.

The author points out that the jawbones of mollusks and the teeth of sharks are an extremely widespread and specific element in deep-water ocean sediments. Data concerning their distribution and abundance, together with data relative to the skeletal remains of other organisms, can be of substantial importance for the description and classification of ocean sediments. ("Interesting Finds on the Floor of the Pacific Ocean," by G. M. Belyayev, Priroda, No. 12, 1960, pages 105-108)

"Priroda" Reviews Book "On the Vityaz' to the Islands of the Pacific Ocean"

The author, Ye. M. Kreps, was a participant on the four-month voyage (November 1957-February 1958) aboard the Vityaz' in the central part of the Pacific Ocean. The work done there was in accordance with the program of the International Geophysical Year. In this interesting book he tells of the research conducted on the voyage, the nature of the ocean, its rich and varied fauna, and about what he saw and learned as a result of a visit to several tropical islands of Oceania and New Zealand. The material in the book is based on the personal observations of the author, on meetings and conversations with the representatives of various classes of the population on these islands. The book is written in lively and absorbing fashion. The photography accompanying the book is collected together in an insert in the back and is a fine supplement to the text.

This book is 172 pages long, with 16 pages of photographs in the form of a supplement. It was published in 1959 and sells for 4 rubles. ("Priroda," No. 2, 1960, page 119)

VI. ARCTIC AND ANTARCTIC

The Influence of Atlantic Waters on the Upper Horizons of Arctic Seas

The author of this article, F. I. Yeskin, begins his paper by citing eleven bibliographic references to the influence of Atlantic waters on the upper horizons of Arctic seas. He points out, however, that there is no unanimity of opinion as to whether Atlantic waters do exert an influence in this respect or to what extent they do so.

This article cites data to demonstrate that Atlantic waters do influence the surface horizons of these seas. The author has made a thorough, prolonged and well documented study of this subject and the text deserves full translation for those interested in Soviet research on this specific topic. ("On the Problem of the Influence of Atlantic Waters on the Upper Horizons of Arctic Seas," by F. I. Yeskin, Vestnik Leningradskogo Universiteta, No. 6, 1960, pages 153-158)

Report on the Geological Structure of Queen Maud Land

This paper, published last year in the Reports (Doklady) of the Academy of Sciences of the USSR, represents a substantial contribution to our knowledge of the geology of the particular area concerned. The full text is about 1,600 words long.

In February 1959 a group of associates of the Institute of Arctic Geology explored the eastern part of the mountains on Queen Maud Land between 9° 25' and 18° 37' E and 71°-72° S for a distance of 300 km, and also the Schirmacher Oasis, situated at the point where the continental glacier joins the shelf ice. These mountains are situated 150 to 300 km (and the oasis -- 80 km) to the south of the new Soviet scientific station Lazarev established at the beginning of March 1959 on the shelf ice at a point 69° 58' S and 12° 54' E. The mountains in Queen Maud Land are one of the largest mountain systems of Eastern Antarctica and extend in a latitudinal direction for almost 1,000 km, from 19° E to 7° E. E. Roots has done work in their western part (1951-1952), but the central and eastern parts of these mountains have remained unexplored until our expedition visited them.

This article was written on the basis of field material collected primarily by the author but also by L. V. Klimov and D. S. Solov'yev.

The subglacial relief of the investigated region is predominantly highly eroded block mountains bounded by deep faults. Along these fault individual blocks of the Earth's crust have been uplifted several kilometers, forming horsts, whereas other blocks have dropped down, forming depressions filled with glaciers. The mountain peaks rise above the ice sheet from several hundred to two thousand meters with absolute elevations up to 3,500 m. The Schirmacher Oasis has a completely different appearance; it consists of groups of low (50-100 m high) volcanic cones and disconnected broad basins whose floors are occupied by shallow lakes. Between the block mountains and the oasis there are nunataks -- individual craggy volcanic cones rising 50 to 300 meters above the surface of the ice sheet. Chains of such nunataks extend to the eastern part of the region where they probably represent the highest peaks of block mountains buried beneath the ice.

This introductory material is followed by a detailed report on the rock types of this particular area, material probably available nowhere else in Antarctic literature. ("Brief Information on the Geological Structure of the Eastern Part of the Mountains in Queen Maud Land in Eastern Antarctica," by M. G. Ravich, Doklady Akademii Nauk SSSR, Vol. 128, No. 1, 1959, pages 152-155)

Soviet Antarctic Workers Visit the South Pole

On 26 December 1959 at 1215 hours Moscow time, a sledge-tractor train of the Fourth Soviet Antarctic Expedition, after an unparalleled crossing of the ice expanses of exceptionally inaccessible regions of Eastern Antarctica, arrived at the South Pole. In 91 days they had covered a distance of 2,700 km from the main Soviet research base -- the Mirnyy observatory.

Soviet polar specialists have made an important contribution to the study of Eastern Antarctica. Our stations have conducted and are conducting observations along the coast, at various sectors on the continental slope (Mirnyy-Pionerskaya-Vostok I) and also in the deep interior regions of the continent -- Komsomol'skaya, Sovetskaya, Vostok (geomagnetic pole), Pole of Inaccessibility. Sledge-tractor trains have become an important means of research. Equipped with various kinds of astrogeodetic apparatus, they have done much for the investigation of the relief, ice cover, surface of the underlying rocks, the Earth's gravitational and magnetic fields, etc. Profiles have been drawn along the routes covered by the sledge-tractor trips.

It was very important to tie in the results of all this work with the data collected by investigators of other countries and extend these routes to the South Pole -- a point which has absorbed the attention of people for decades.

The South Pole is not the most inaccessible point in Antarctica. It is not really very distant from the shores of the Ross Sea and Weddell Sea. However, only a few land expeditions have reached the Pole. The American polar station Amundsen-Scott at the South Pole was organized and is supplied by aircraft. It is especially difficult to reach the Pole from the coasts of Eastern Antarctica.

The traverse was made in several stages. Along the route followed we re-established the station of Komsomol'skaya and transformed it into an intermediary base. The most difficult sector of the traverse was the final one -- from the station of Vostok to the South Pole, a distance of 1,280 km. It passed through the limitless expanses of ice of the Sovetskaya Plateau at elevations greater than 3,000 meters. Because of the great elevation the supply of oxygen was decreased and this was keenly felt by the men. No man had ever passed this way before. Sixteen courageous polar explorers, headed by the Chief of the Fourth Antarctic Expedition, A. G. Dralkin, regularly stopped for scientific observations in accordance with a set plan. It was exceedingly cold and it was necessary to overcome the loose snow in which the vehicles often bogged down.

This final travers was made in two powerful "Khar'kovchanka" snow vehicles and a heavy cross-country tractor supplied with astronomical, radio navigational and other instruments.

The Soviet polar specialists were warmly greeted by the men wintering at the American station Amundsen-Scott. They passed three days with the Americans. A flag-raising ceremony was held there -- the red banner of our Motherland was hoisted above the South Pole, together with the flag of the United Nations Organization.

Scientific observations were also made at the South Pole, including repeated seismic sounding observations of the thickness of the ice sheet; the ice sheet is approximately 2,500 m thick at this point. Inasmuch as the station South Pole is situated at an elevation of 2,765 m, we may conclude that the bedrock rises approximately 250 m above sea level.

Parting as friends with the American researchers, the Soviet members of the sledge-tractor team started their journey back. ("Soviet Polar Specialists at the South Pole," unsigned article, Priroda, No. 2, 1960, pages 103-104)